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No. 4.

AUGUST, 1888.

SOME NEW YORK MINERALS AND THEIR LOCALITIES,

Prepared for the New York State Museum of Natural History,

BY

FRANK I. NASON.

PRINTED FOR THE MUSEUM.

ALBANY:

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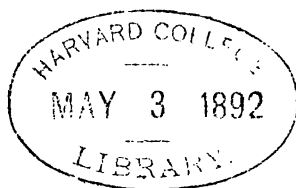
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N. J. State Museum

INTRODUCTION.

This bulletin has been prepared at my request by Mr. Frank L. Nason, of the Geological Survey of New Jersey, formerly of the Rensselaer Polytechnic Institute of Troy.

Mr. Nason was employed for a time by the State Museum to assist in the work of arranging for exhibition the general collection of minerals; and, also, in collecting minerals in Essex and Warren counties.

Three suites of minerals in the general mineralogical collection of the Museum are noticed in this bulletin. And it is divided into the following parts, descriptive of these three several collections:

1. A description of a new locality of fine brown tourmaline and associated minerals, brought to the notice of the Museum by Mr. C. E. Beecher, consulting palæontologist of the New York State Museum and assistant in the Yale University Museum.

2. A notice of some pyroxenes and associated minerals, found at the Chilson Hill mine, in the town of Ticonderoga, Essex county, by C. E. Beecher and Frank L. Nason.

3. Calcites collected by the late Prof. E. Emmons, State Geologist, at the lead mines of Rossie, St. Lawrence county, N. Y.

The first and second collections, here mentioned, represent the direct work of the Museum within the past two years; the last represents, also, although indirectly, work done about fifty years ago.

No attempt has been made to give a strictly technical description of the minerals noticed, but it is hoped that this bulletin may serve to direct the attention of students to them and to some special features of the Museum collections.

JOHN C. SMOCK,

Assistant-in-charge N. Y. State Museum.

ALBANY, N. Y., August, 1888.

SOME NEW YORK MINERALS AND THEIR LOCALITIES.

I.—NEWCOMB TOURMALINES.

There are many specimens in the collection which, for various reasons, demand more than casual mention. Among these may be noted, material from a newly discovered locality at Newcomb, Essex county, N. Y. This locality has yielded some of the finest specimens of brown tourmaline yet found. The exact position of the bed is on the south shore of Lake Harris about one mile east of the post-office in Newcomb. These tourmalines occur in the Laurentian limestones which are so abundant in the valleys of the Adirondacks. The same limestones occurring in the northern part of New Jersey, in Orange county and in northern New York, all bear more or less brown tourmaline. The most famous locality, however, is Gouverneur, N. Y. For the most part, the tourmalines occurring in other places are very fragmentary, presenting the appearance of having been nearly dissolved after being formed. It is not of infrequent occurrence that crystals are found having only one or two of the R-faces present with traces of the prism, or that a fine termination is present with a diameter of one to three cm. with the c. axis no more than five mm. in length. In other cases mere crystalline shells appear, or fine veins may be completely filled with the formless mass. In general the mineral is only feebly transparent and more usually opaque. Even when in large, finely developed crystals the contrary is a rare exception. In many cases, however, the opacity of the crystal is due to numerous fine shivers passing in every direction, and there is a decided cloudiness which renders the crystalline masses opaque. Many of the larger crystals have a single termination at one extremity, while the other will have from two to twelve distinct terminations, and should the inclosing calcite be dissolved away for a short distance, they would give the impression of as many distinct crystals having

a parallel growth. Color is also a varying characteristic of these tourmalines. In northern New Jersey, for instance, the crystals have a faded, appearance, evidently not arising from incipient decomposition, since, on all sides they present a highly vitreous lustre, and the polish of the surfaces is hardly broken. So far as instances have come under my personal observation this rule admits of hardly an exception. In the New York limestones, however, even when the color is not deep there is a vividness about them which makes a decided contrast to the New Jersey crystals. I mentioned the fact that these crystals often had the appearance of being nearly or quite dissolved. In addition it will be well to state that this condition is owing to other causes than solution. Within most of the crystals of larger size, rounded masses of calcite, as coarsely crystallized as the surrounding rock, are enclosed and also globules of quartz.

The tourmaline is distributed irregularly through the entire mass of the limestone in the localities named. Graphite, apatite, sphene and wernerite are associated with it. Quartz, crystallized, is found very rarely, but it is quite abundant, either as irregular shaped, pitted nodules or as flattened and warped plates with the same pitted appearance. The graphite occurs in thin laminae, often in decidedly hexagonal tablets. Though generally lying between the crystals of calcite and parallel to their faces it often cuts through them irregularly and is found enclosed in the body of nearly all of its associates.

The limestone itself is very coarsely crystalline, some of the cleavage surfaces measuring a cm., more or less. The color varies from a dull grayish-white, to white, blue and red. Cleavage pieces vary from dull opaque-milky to almost transparent.

The foregoing, are briefly, the general characteristics of the Laurentian limestones in localities which I have visited. In the immediate vicinity of Newcomb these characteristics remain the same. Everywhere are evidences of intense metamorphism.

One very limited area, however, presents an entirely different appearance. The area covered by the "brown tourmaline locality," is about ten feet wide by fifteen broad, and from three to five feet in depth. In this pocket the limestone has been changed to an almost transparent, yellowish-white and coarsely crystallized calcite. Embedded in this gangue the following minerals were found in good crystals, some very fine: Tourmaline, brown and green, blue apatite, sphene,

zircon, muscovite, smoky quartz, scapolite, albite, graphite, tremolite, pyroxene and pyrite.

The difference between the enclosed minerals is even greater than between the limestones within and without this area. The tourmalines are occasionally of very large size; one crystal measures eight inches in length by four inches in breadth, or twelve inches in circumference. Excepting on the surface, and thus exposed to weathering, the crystals are all remarkably fresh in appearance. They are of a rich brown or green color (rarely greenish-black and subtranslucent, from depth of color), and perfectly transparent. A large number were found entirely free from flaws and furnished beautiful gems, though of small size. The greater number of the stones thus cut were fragments of crystals. A number of crystals were found, however, of the length of five to ten mm., doubly terminated and without a flaw. Larger crystals, from one to two cm. in diameter, are very clear and are translucent notwithstanding their many flaws. Fragments, which would cut a fine stone, may often be broken from these crystals.

These tourmalines show no new or even rare faces. The zero plane is of infrequent occurrence. The general habit of the crystals is short and stout. They often exhibit a parallel growth of a large number of crystals, having a common termination with adventitious crystals of shorter length along their sides. The phenomenon before mentioned, of one crystal having a single termination at one end and several at the other, is here of frequent occurrence. These crystals also enclose large rounded globules of calcite, and occasionally of quartz. Graphite and scapolite are of more rare occurrence. It not infrequently happens that large, beautiful and apparently perfect crystals turn out to be no more than thin shells or series of shells, enclosing masses of calcite. Sometimes one termination will be perfect, with the body of the prism a mass of cells; or the prism faces will be apparently perfect, while the terminations are entirely wanting. Thin plates with the polished surfaces of the R-faces are very common. Finally, fragments of quartz and scapolite are often found with innumerable fine veins filled with tourmaline.

Another mineral of common occurrence in this locality is sphene or titanite. It is found in very small, tabular-shaped crystals, and more rarely in crystals of eight cm. or more in length, and with corresponding dimensions. In color the crystals range from nearly black to chocolate, brown, red and clear honey-yellow; varying from opaque to semi-transparent.

In many of the larger crystals there is a very distinct cleavage, more nearly perfect than usual and, seemingly, to be referred to the same cause which, according to Dr. G. H. Williams (*Am. Jour. Sci.*, Vol. XXIX, p. 486), produces the apparently perfect cleavage in many American sphenes. Twinning in the smaller crystals with the re-entrant angles, "arrow twins," is the most common.

Large crystals quite frequently are found evidently altering to rutile. At least one large crystal was found having long needles of rutile, fifteen mm. in length by one to two in diameter. The mineral gives a strong fetid odor when struck; before the blow-pipe it changes from a dull gray to a translucent honey-yellow, fusing at about four to a grayish-black glass; in the closed glass tube it gives off considerable water. Calcite is intimately mingled with the crystal, but whether from inclusion or the result of decomposition, I cannot say. There are yellow crystalline (zanthitone?) substances enclosed, which give distinct titanium reactions. The enclosed rutile crystals, splendid, show a distinct crystalline form, and are distributed irregularly throughout the mass of the crystal. The fetid odor is probably due to the presence of sulphur, since it loses this odor when heated.

Perfect crystals of tremolite are also found, rather dark in color, but yet translucent. Beautiful, translucent crystals of blue apatite are very abundant, but are too small to be of much value as cabinet specimens. They occur in the calcite, though often penetrating crystals of wernerite.

The zircons found in this locality are deep greenish-black, and are opaque except on the edges. The crystals are of the simple prism combined with one set of pyramidal planes. They are not numerous.

Pyrite is found in large octahedral crystals, and always much decomposed. In many cases decomposition is complete.

In form the smoky quartzes are somewhat unusual, though not at all rare. The pyramidal faces are, in the majority of cases, wanting, the crystal terminating in a long taper, the result of successive attempts at termination. Though the crystals are usually very clear and transparent, it is not noticed at first on account of the roughened, apparently corroded faces. Crystals are found, however, with polished faces, having the appearance of quartz partially dissolved, and having a "washed-out" or faded color. Quartz of a milky-white color is found, but such crystals are not common. They follow the general form of the smoky quartzes.

Muscovite occurs of a clear, yellowish-green color in the direction of the a. axis, but reddish-brown in the direction of c., and viewed through a., it is transparent; through c., feebly translucent in thick crystals. The largest crystals are no more than two cm. by one or one and a half. The general hexagonal form of the crystal is easily distinguished, though perfect faces are rare.

The albite occurs in druses generally, though some crystals are from one to three mm. long, and these druses are glassy and perfectly transparent. The mineral occurs coating the surfaces of all the other minerals, and sometimes filling seams of broken crystals. Fragments of large, translucent crystals are found measuring more than five cm. in diameter. These fragments often have a beautiful, pearly lustre and a soft opalescence. Very handsome stones have been cut from some of these fragments.

Graphite occurs much in the same form as in the surrounding limestones, though apparently not quite as abundant.

Dipyre crystals occur from minute drusy, to large crystals, five to ten cm. in length. All are glassy, translucent to transparent, and in color, vary from a grayish-green to apple green. Large crystal-line masses occur, enclosing crystals of sphene, penetrating quartz and tourmaline, and the surface of the masses, as it reaches into the enclosing calcite, is covered with glassy, drusy crystals, though some are of considerable size. The dipyre crystals also have the pitted appearance, as though incipient fusion had taken place, or solution had begun to remove part of the mass. The large crystals enclose in globular cavities masses of perfectly crystallized calcite.

Many crystals have long, dark, acicular enclosures, which are arranged parallel to the vertical axis with great regularity. These acicular crystals vary from one to fifteen mm. or more in length. Some are barely visible to the naked eye, while others, show a splendid metallic lustre when properly turned. Some crystals are apparently free from these enclosures, but the microscope reveals them in great numbers. In general, under the objective they are too minute to give any intimation as to their form. They are usually nearly or quite opaque. What little light is transmitted appears of a reddish brown.

Rosenbusch, in his "*Mikroskopische Physiographie*," second edition, page 318, describes minerals of the scapolite group occurring under similar conditions and containing similar inclusions, but in the granular limestones, the crystals are quite regular and free from

inclusions. With the exception of muscovite and quartz inclusions and the fact that the mineral occurs in granular limestones, Rosenbusch's description is quite applicable to this mineral. Since there is no way of distinguishing wernerite from dipyre, save by chemical analysis, a quantitative silica determination was made. The average percentage of silica was 57.20. Since the percentage in wernerite ranges from 44 to 48 per cent, and in dipyre from 55 to 60 per cent; and, since both Hussak and Rosenbusch agree that rutile is a rare inclusion in wernerite, I think the mineral may safely be called dipyre.

II.—CALCITES FROM ROSSIE, ST. LAWRENCE COUNTY.*

The calcites from Rossie, N. Y., collected by Prof. E. Emmons, deserve special mention. They were taken from the Coal Hill and adjoining lead mines in the town of Rossie, St. Lawrence county. The mine was opened about 1836, but was operated at a loss, and was abandoned a few years later. During the process of working, however, some of the finest calcites in the world were obtained. Of these, the Museum has, probably, the finest and most extensive collection extant. All the different forms figured by Prof. Beck in his "Mineralogy of New York," and by Prof. J. D. Dana in his "System of Mineralogy," with a few exceptions, are represented.

There are no unmodified rhombohedra, and it is quite probable that none were found. Scalenohedra of the simple type are not common. Every crystal, without exception, is twinned, some of the twins being very complex. The descriptions given by Prof. Beck, will be found on page 224, "Mineralogy of New York." The twins found at Rossie are usually parallel to the O-face. Sometimes the O-plane is present on one of the crystals and not on the other, sometimes on both, and then on neither.¹ It frequently happens that when two crystals are thus twinned only three of the R-planes of each crystal are present, while the O-planes are developed to such an extent that the crystals appear in the form of a thick, triangular crystal with bevelled edges, or rather, in the form of a truncated triangular pyramid.²

In another form two crystals are twinned parallel to i. and to a third crystal parallel to the O-face.³ On two crystals the O-face is developed, on the third it is lacking. Not rarely crystals are found with from

* Collection made by the late Prof. E. Emmons, of Williams College, about 1838, at the Rossie lead mines.

¹ For references see plate at the end of Bulletin.

² see fig. V.

³ This form is a combination of fig. III with one of the twinned crystals of fig. V.

one to three thin lamellæ, twinned between crystals twinned parallel to the O-face.¹ On account of the developing of one crystal more than another, or the unequal development in different directions, forms, though in reality quite simple, appear at first very complex. For instance, a crystal in the collection and which will be readily recognized, has the appearance of two oblong rhombohedra placed parallel to a cleavage face, while a third crystal lies in the re-entrant angle. In reality two crystals are twinned parallel to the O-face, and one is so developed that it nearly shuts in the smaller one.²

A peculiar feature of all crystals is that the R-faces of the primary are all more or less roughened, the O-faces decidedly so, while the other R-faces and the scalenohedral planes are highly polished. In some crystals this seems to be simply due to etching, but in others to a subsequent deposition of matter of less purity. In this latter case the last addition has a milky opacity. Additions never seem to take place on any but the primary rhombohedral and zero planes.

Prof. Beck seems to infer that the roughness of these crystals is due to incipient solution on the surface. The results of my studies lead me to a different conclusion. A cleavage piece was taken from one of these roughened crystals and placed under a low power objective. The piece was then examined by reflected light. Focussing as nearly as possible and turning a bright ray of light on the fragment, the light was simultaneously flashed from a large number of the apparently rough points. On turning the stage about 90° , the light was again flashed from a large number of planes. As these planes were parallel to the cleavage lines of the crystal, it appears to me that this roughness must be referred to the regular development of the crystal in a manner analogous to the striæ on the prism faces of quartz.

In case of the milky coatings, however, though the roughness is again due to rhombohedral faces, there was evidently an interrupted growth of the crystal. This is evident, since between the crystal and its coating is a thin layer of iron pyrites. The secondary coatings are not, however, always of a less degree of transparency than the body of the crystal. In one or two instances the rhombohedron was developed, the growth interrupted, a deposition of cubical pyrite followed, and finally the crystal received fresh additions, but each of the rhombohedral planes was replaced by two sets of scalenohedral planes, thus giving the crystal the appearance of a tetrahexahedron. There

¹ Twinned lamellæ placed between the twinned crystals, fig. V.

² Fig. II gives a partial representation of this instance.

is one crystal of great beauty which shows these characteristics to perfection.

There is yet another form in which the calcite occurs. This, though not as interesting as the other, is yet worthy of notice. In this form the mineral appears in large, branching masses having much the appearance of coral. These branches are made up of fine scalenohedrons coating the surface of larger crystals. Among these branches are small, medium sized, and quite large crystals of celestite, a mineral very common in this locality.

According to Emmons, the vein in which these minerals occur cuts through a gneiss formation.

Associated with the calcite were found fine, large crystals of galenite; pyrite, in cubic and octahedral crystals; sphalerite (in many cases, crystals of exceptional beauty), and also celestite.

Though Rossie has, without doubt, produced the finest crystals, yet other towns in St. Lawrence county, have produced crystals remarkable on account of their size. The neighboring county of Jefferson has contributed the largest of any. In the Museum there is a fine, large crystal from Oxbow, a post-office in Antwerp township, measuring 12x10x10 inches. The crystal, though very bright and fresh looking, has been attacked by weathering. Very large and perfect scalenohedrons are also found in this locality. The Museum has good representatives of these also.

III. — PYROXENES FROM THE MINERAL LOCALITY AT CHILSON HILL, TICONDEROGA, N. Y.

The locality at Chilson Hill, Ticonderoga, Essex county, is the site of the old graphite mine of the American Graphite Co. The mine has now been abandoned for about thirty years. It was not abandoned on account of exhaustion, but the great depth, the great influx of water, together with the discovery of a new locality at Hague determined its shut-down for a time. Though the new mine at Hague yields a poorer grade of ore and is worked with greater difficulty, I am told that on account of the heavier minerals with which it is associated and which render washing and refining so much easier, the new workings pay much better. At Hague the graphite occurs in a gneiss vein, while at Ticonderoga it occurs in a gangue of calcite. It is this vein of calcite located in the gneiss which bears the minerals of this locality. Here as in nearly all mines what is valued by mineralogists

is to be found in the "dump." As the tunnels and drifts were run, the wall-rock encountered was thrown in one place while the "undressed ore" was carried to the surface and sorted. Lying as these sorted lumps have lain for so many years exposed to the weather, one would not expect to find minerals in a fresh condition, but the locality is more interesting on account of other things than the intrinsic value of the minerals. Yet it is of no rare occurrence to break a large mass of calcite and to find enclosed, perfectly fresh and undecomposed crystals of pyroxene.

The following is a list of the minerals found by me in this place : Pyroxene, scapolite, quartz, graphite, apatite, sphene, calcite.

The pyroxenes found here are peculiar on account of their size, the inclusions which they carry and their external appearance. There are at present, in the Museum, two of the largest ever found in the State and probably in the world. The largest of the two measures thirty-six inches in circumference and eighteen in length. The second one is about eighteen inches in circumference by twelve in height. Both crystals have their prism planes perfectly developed, the prism planes I and i-i (Dana) being both present and about equally developed. Basal planes in both cases are lacking, appearances favoring the idea that each is a fragment broken from larger crystals in blasting or in dressing the ore. They are badly decomposed, though as yet quite firm. The crystals are coarsely lamellar, parallel to O, the lamellæ varying in thickness from two to five mm. In external appearance they are very rough, though the indentations are not deep. These indentations are more like long, rather deep and interrupted striæ. It is rarely that the calcite causes a real indentation, though when in contact with quartz the pyroxene is always moulded around it, never penetrating it. In the fresher crystals which are broken from the calcite the latter mineral is found closely fitting into the striations, and has a peculiarly fine, granular, crystalline structure. The prism angles of all crystals are quite sharp, but when the crystals are terminated by pyramidal faces the interfacial angles are invariably rounded. In the body of the crystals, especially the larger ones, are enclosed rounded globules of well crystallized calcite and quartz. These masses vary in size from inclusions of microscopic dimensions to that of a walnut. Under these circumstances the calcite can be in no way distinguished from that outside the crystals. Graphite is a very common inclusion. Thin lamellæ of graphite occur within the body of the pyroxene and also gashing the exterior of the crystals. Large

as the crystals occur, they are not always to be found of extraordinary size. The mineral often occurs in exceedingly compact, tough masses, cleavage well developed, but with no trace of a crystal form, save when a mass of calcite is enclosed, when the surface in contact will have either prism faces or terminal faces well developed. Occasionally tough fragments of this nature will be found, thrown out by blasts, which show a passage from the tough, compact crystalline mass, with little or no calcite to a side of the block where will be a gangue of calcite literally packed with small, doubly terminated crystals of pyroxene. If a little care be exercised in breaking off a piece, a fragment can be obtained which, when treated with acid, will leave a perfect network of interlaced crystals of varying sizes.

Quartz is another mineral which occurs in this locality, and though neither beautiful nor rare in form, yet possesses much of interest to one who chooses to study it. It invariably occurs in forms which Emmons and others have denominated "fused." Exactly what is meant by this term does not clearly appear; but certainly, taken in its literal meaning, it is untenable, whether aqueous or purely igneous fusion is meant. Nor can I bring myself to believe the peculiar forms to be the result of partial solution. In general the crystals have the appearance of being water-worn, or of perfect crystals having been rolled until the angles are all more or less rounded. In some cases no crystal form can be distinguished, only globular or lenticular shaped masses are the result. These globules vary in size in the same mass of calcite. Again, it is of frequent occurrence that a rounded, "worn" crystal will be found an inch or more in length by one-half inch in diameter beside a slender crystal an inch or more in length but with a diameter of less than one-fourth. The angles of the smaller crystals will also be as perfect as those of the larger. In short, crystals will lie side by side, one nearly perfect, the other with no trace of angularity. It is also common to find large clusters of crystals, all having this "fused" or "worn" appearance and completely imbedded in the calcite. Lest I have not emphasized this latter idea, I will repeat that all of the quartzes thus far spoken of are completely imbedded in the calcite. The walls of many of the veins are lined by large patches, several feet square, of these crystals, having individual terminations, rounded as before, and with an unindividualized base. Deep indentations often occur in these crystals, amounting to more than one-half of their diameter. Crystals are often found with a saucer-shaped de-

pression where the apex of the pyramidal faces should be, while the pyramidal planes meet in a rounded edge about the depression.

The inclusions of quartz are confined exclusively to graphite. This latter mineral occurs gashing the quartz in the same way as it does the pyroxene.

Of the graphite but little need be said as in appearance it differs but little from the ordinary occurrence. Disseminated through the bodies of other crystals it occurs in the usual six-sided tablets. There is one form, which is quite frequent here, which Dana's Mineralogy describes as of rare occurrence. This is the radiated, globular mass. These globules, the size of a buckshot, have been found by Mr. Beecher and myself, and there are specimens of them in the Museum at Albany. They have not been found except in the calcite. The tablets enclosed in the calcite cut the prisms at all angles, and even when lying approximately parallel to any face, the graphite is apt not to lie in one plane, but to have a warped surface.

The scapolite group is represented by a mineral which is assumed, pending analysis, to be wernerite. It occurs in the usual simple form, but rarely with rounded angles. Microscopic sections show infiltrated veins of radiating chalcedony. Nearly all specimens are more or less decomposed. Apatite occurs here in such small quantities as hardly to deserve notice, yet, on account of its presenting the same "fused" appearance as the other minerals, it is mentioned. It has the same light green color as nearly all of the apatites found in the Laurentian limestones. About the same degree of transparency also obtains. In form they have the simple prism and pyramidal faces with the O-faces occasionally developed. They vary in size from crystals a foot in length with a diameter of from one to two inches, to slender crystals one-eighth inch in diameter and from one to two in length. The crystals occur usually in the calcite but are sometimes found modifying and being modified by contact with quartz and pyroxene. The mineral differs in this respect from all others noticed, in the fact that however irregular or "fused" its surface may appear it is always with a perfect polish.

Sphene occurs in crystals never more than one-half inch in length and of the usual simple form. Its occurrence is limited to the compact masses of pyroxene, or where pyroxene, calcite and graphite are intimately mingled.

It remains now to mention the calcite which occurs here. It is in reality the "veinstuff" or gangue of the mineral sought as well as

of the others. Though never found in perfect crystals, it is yet perfectly crystalline. In color it is a light straw yellow. It can often be cleaved in perfect rhombs from one to five inches across the face. On every rhomb, striæ run diagonally across the faces, indicating the fact that, as usual, the mass is twinned, not simple. In fact, many times the mass will part parallel to these twinning striæ rather than to the prism faces.

The appearance of the mineral is also much modified by its associations. Whenever enclosing another mineral, the cleavage surfaces always present a warped appearance. This warping varies directly with the size and number as well as with the variety of the mineral enclosed. In the first case, suppose the enclosed mineral, say a crystal of pyroxene, be very small: then the warping would be noticed with difficulty, if at all, whereas if the size of the crystal were increased the warping would extend over a surface of two or more inches across, with a departure from a straight line, at that distance, of nearly one-fourth of an inch.

In addition to the warping there will also be noticed a granulation extending various distances from the surface of the crystal. These granulations are nothing but smaller crystalline masses surrounding the enclosed mineral, which, for some reason, have not been free to assume the more coarsely crystalline state. This peculiar aggregation conforms closely to the shape of the enclosed crystals, though, as it reaches away from the enclosure, the angularity is lost. Unfortunately there was no opportunity to test this peculiarity in connection with the largest crystals, since they were wholly free from the calcite. If, however, the bulk of the surrounding calcite was not proportionate to the size of the crystals, the warping must have been very great.

Thus far the facts of occurrence, of these minerals as well as those from Newcomb, alone have been stated. The question now arises, do these facts warrant any other explanation than that of the fusion theory? It is difficult to understand how either dry, or aqueous fusion could have produced these results. In both cases it would seem that in cooling slowly they would have assumed their original form, if, indeed, we could safely assume a perfect form originally. This explanation is too complex, when a simpler one is at hand, which appears to answer every purpose. The explanation by the assumption of a partial solution appears to involve even greater difficulties. For, while there is no doubt that a sufficient degree of heat could be

obtained and an abundance of a solvent agent, it appears impossible to explain why the smallest crystals always have the most nearly perfect form, and that, even, when a large crystal and a small one lie close to each other in the gangue. If a large crystal of calcite be dropped in an acid solution together with a smaller one, it will invariably follow that the smaller will disappear first, and that it will wholly lose its external form before it so disappears. The same holds true of all easily dissolved minerals, and it appears safe to assume it true of minerals like quartz, pyroxene, apatite, etc., which are more refractory.

Again, the abundance of free silica present would render the accounting for the silica removed by solution a task by no means easy. Not only does the "country rock," which in this case is gneiss, contain much quartz, but the walls of the veins are in many cases completely covered with quartz crystals, "fused," and with their apices pointing towards the center of the vein. It would seem as if, had the solvent action been present, the silica would have been carried into the vein, not out of it, especially when such an abundance of bases existed in the form of lime.

It seems as if minerals could readily be divided into three classes. First, those formed by volatilization; second, those formed from solution; third, those formed by segregation in beds or veins while undergoing metamorphism. As examples of the first class crystals of sulphur formed in volcanoes, the different chlorides, etc., found under the same conditions, may be given, to which may, in all probability, be added the diamond. Minerals of the second class may be recognized by their fluid inclusions, such as quartz, and many may be formed artificially. Of the third class, the mineral constituents of rocks, such as granites, gneisses, diorites, may be given. Intrusive veins, dykes, and veins of segregation, whether metalliferous or not, would also come under this third division.

Among rocks that are wholly crystalline, it is impossible that their mineral constituents should be deposited from solution in the sense in which the word is usually employed. Each mineral, if indeed any individuals existed in the beginning, would be in a semi-fluid or pasty condition. As time went on each would separate more or less perfectly from the mass, and as nearly as possible each would assume its peculiar form. With large rock masses, however, which Rosenbusch designates as "hypidiomorphic-granular," individualization is rendered impossible from lack of space, and from the fact that the factors of solution are nearly the same in the case of each. In fact

the "allotriomorphic" and "riliomorphic," designated by the same author, could be explained by means of the well founded assumption of more rapid crystallization of some minerals than others.

From the well known homogeneity of granites and gneisses this inference can be legitimately drawn. At the same time, it is easy to imagine exceptions to these circumstances which would allow a mineral to assume its own form with greater or less perfection, and such exceptions are actually found. Let a cavity, however small, be formed in a rock undergoing metamorphism and it will bristle with crystals either of quartz, feldspar or mica or all together. It will also be readily called to mind that in coarsely crystalline rocks that the quartz is usually the gangue in which perfection of form most readily occurs. Minerals, such as spodumene, feldspar, beryl, triphylite, tourmaline, etc., which are found at the spodumene locality at Huntington, Mass., have great perfection of form, irrespective of size, so long as they are developed in quartz, but at once lose their individuality when masses of feldspar and mica occur. It is quite rare to find these minerals in the feldspar and mica, but when they do thus occur they are invariably misshapen. To those who are familiar with the occurrence of zinciferous minerals in the calcite gangue of the Franklin Furnace and Ogdensburg zinc mines in New Jersey, additional facts will readily offer themselves. It is comparatively rare in these localities to find minerals in the gangue with sharp angles and perfected forms.

Among miners the term "shot ore" is employed to designate a mass of ore perfectly crystalline and well individualized save external form. This external form is produced by the great amount of mineral matter attempting to crystallize in a limited space. The phenomenon is noticed more frequently in iron and zinc ores, but it is by no means confined to them. In the garnet beds or pockets so abundant in Warren and Essex counties, N. Y., by far the greater number of these deposits break up in a manner exactly similar to the "shot ores" of the miners. In one place in Thurman, N. Y., a bed or pocket of hornblende is similarly formed.

Again the deformation and distortion of nearly every species of minerals, deposited from solution, in space, limited either by size of cavity or by interference with each other, are ample evidence that such distortion may occur from crowding. Evidence might be also adduced from the class of pseudomorphism where one mineral fills a cavity formed by another, which has been removed by solution. The same

line of reasoning would also be favored by the common explanation of infiltrated veins which have been "locked."

Finally I would say that there seems to me to be the best of reasons for discarding the explanation ordinarily adopted in all cases, namely, by corrosion or by imperfect crystallization, a worse explanation, which does not explain at all. In a vein of infiltration and in very many other individual cases, corrosion may be and probably is the correct explanation. But in veins of segregation, or in highly metamorphic rock masses where crystals occur with rounded angles and edges, neither "fusion" nor "corrosion" appear equal to the task which is set for them.

Explaining their forms, however, by saying that they are the result of crowding, or growing in a pasty mass, or of a general crystallization throughout the entire mass, clears away much that is otherwise hard to explain and affords at least an excellent working hypothesis.

EXPLANATION OF THE PLATE.

All the figures given in this plate are copied from drawings in Prof. Beck's Mineralogy of New York. These drawings were made from crystals in the possession of Prof. Emmons, and the crystals are now on exhibition in the Museum.

The crystallographic nomenclature has been changed to the corresponding symbols of Dana's "System of Mineralogy."

With the exception of fig. 1, each crystal is selected to illustrate one point only, and the crystal is drawn simply according to its primary form. For the rare planes so common to all of these crystals the reader is referred to the illustration in Dana's "System of Mineralogy."

Fig. I. Rhombohedron, with its edges replaced by scalenohedral planes.

Fig. II. Two crystals twinned parallel to ii ; one crystal much larger and more perfectly developed than the other.

Fig. III. Two rhombohedrons twinned parallel to $i-i$.

Fig. IV. Rhombohedra in which the O planes are developed. This is frequently carried to such an extent that the crystal is reduced to a thin plate on which the rhombohedral planes are observed as mere bevelments.

Fig. V. Two crystals twinned parallel to O . Crystals sometimes much distorted through unequal development.

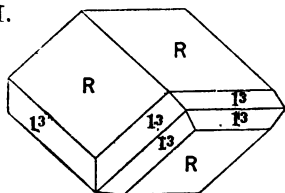
Fig. VI. Distorted crystal of fig. V. The crystal is probably hemimorphic.

Fig. VII. Scalenohedral planes developed at the expense of the rhombohedral planes. The reverse of fig. I.

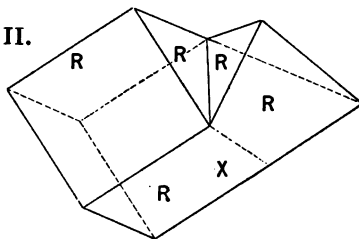
Figs. VIII and IX. Distorted and twinned crystals. These forms are common though much more complex.

PLATE I.

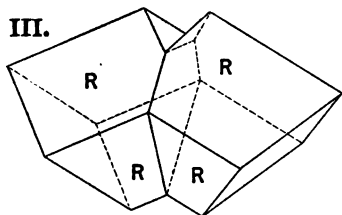
I.



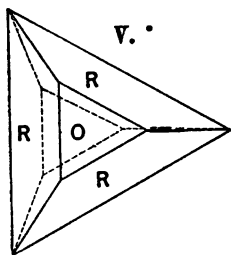
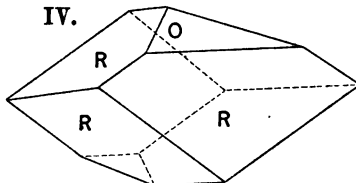
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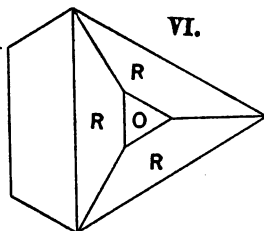
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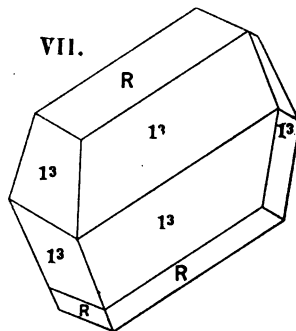
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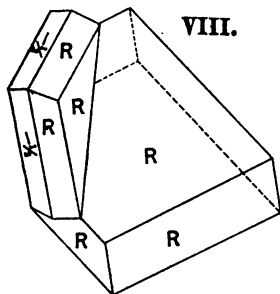
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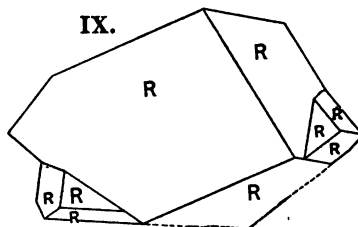
VI.



VII.



VIII.



IX.



